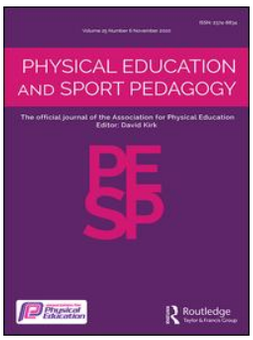

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Do goal clarification and process feedback positively affect students' need-based experiences? A quasi-experimental study grounded in Self-Determination Theory

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ABSTRACT

Background: The importance of clarifying goals and providing process feedback for student learning has been widely acknowledged. From a Self-Determination Theory perspective, it is suggested that motivational and learning gains will be obtained because in well-structured learning environments, when goals and process feedback are provided, students will feel more effective (need for competence), more in charge over their own learning (need for autonomy) and experience a more positive classroom atmosphere (need for relatedness). Yet, in spite of the growing theoretical interest in goal clarification and process feedback in the context of physical education (PE), little experimental research is available about this topic.

Purpose: The present study quasi-experimentally investigated whether the presence of goal clarification and process feedback positively affects students' need satisfaction and frustration.

Method: Twenty classes from five schools with 492 seventh grade PE students participated in this quasi-experimental study. Within each school, four classes were randomly assigned to one of the four experimental conditions ($n = 121$, $n = 117$, $n = 126$ and $n = 128$) in a 2×2 factorial design, in which goal clarification (absence vs. presence) and process feedback (absence vs. presence) were experimentally manipulated. The experimental lesson consisted of a PE lesson on handstand (a relatively new skill for seventh grade students), taught by one and the same teacher who went to the school of the students to teach the lesson. Depending on the experimental condition, the teacher either started the lesson explaining the goals, or refrained from explaining the goals. Throughout the lesson the teacher either provided process feedback, or refrained from providing process feedback. All other instructions were similar across conditions, with videos of exercises of differential levels of difficulty provided to the students. All experimental lessons were observed by a research-assistant to discern whether

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manipulations were provided according to a condition-specific script. One week prior to participating in the experimental lesson, data on students' need-based experiences (i.e. quantitatively) were gathered. Directly after students' participation in the experimental lesson, data on students' perceptions of goal clarification and process feedback, need-based experiences (i.e. quantitatively) and experiences in general (i.e. qualitatively) were gathered.

Results and discussion: The questionnaire data and observations revealed that manipulations were provided according to the lesson-scripts. Rejecting our hypothesis, quantitative analyses indicated no differences in need satisfaction across conditions, as students were equally satisfied in their need for competence, autonomy and relatedness regardless of whether the teacher provided goal clarification and process feedback, only goal clarification, only process feedback or none. Similar results were found for need frustration. Qualitative analyses indicated that, in all four conditions, aspects of the experimental lesson made students feel more effective, more in charge over their own learning and experience a more positive classroom atmosphere. Our results suggest that under certain conditions, lessons can be perceived as highly need-satisfying by students, even if the teacher does not verbally and explicitly clarify the goals and/ or provides process feedback. Perhaps, students were able to self-generate goals and feedback based on the instructional videos.

Introduction

The importance of clarifying goals and providing process feedback for student learning has been widely acknowledged, both in the broader educational (Hattie and Timperley 2007; Sadler 1989; Shute 2008) as in the physical education (PE) literature (Borghouts, Slingerland, and Haerens 2017; Hay and Penney 2009, 2013; Leirhaug and MacPhail 2015; MacPhail and Halbert 2010). Yet, in spite of the growing theoretical interest in clarifying goals and providing process feedback in the context of PE (e.g. Hay and Penney 2009, 2013), it has been noted that very little empirical research (Lorente-Catalán and Kirk 2014) is available about this topic. As such, literature calls for a shift from theoretical work towards empirical studies (e.g. Leirhaug and Annerstedt 2016; Lorente-Catalán and Kirk 2014).

From a motivational perspective (Ryan and Deci 2017), clarifying goals and providing process feedback are argued to contribute to a structured learning environment (Aelterman et al. 2019). Such structure is positively related to students' most volitional forms of motivation, as students get the opportunity to feel effective (i.e. need for competence), feel more in charge over their own learning (i.e. need for autonomy) and experience a more positive classroom atmosphere (i.e. need for relatedness) (Cheon, Reeve, and Song 2019; Mouratidis et al. 2013; Pat-El, Tillema, and van Koppen 2012).

Observations of PE lessons have demonstrated that the implementation of goal clarification and process feedback shows room for improvement (e.g. Leirhaug and Annerstedt 2016; Leirhaug and MacPhail 2015; López-Pastor et al. 2013). This may be because teachers might not possess the essential competence to successfully integrate goal clarification and process feedback into their regular teaching repertoire (Leirhaug and Annerstedt 2016). As such, concrete evidence-based practices are warranted (Georgakis and Wilson 2012; Ní Chóinín and Cosgrave 2013). Experimental studies that examine the impact of goal clarification and process feedback in PE lessons, rather than in a lab setting (De Meyer et al. 2016), can provide such evidence-based pedagogical practices. Therefore, the present quasi-experimental study investigated whether the presence of goal clarification and process feedback positively affects students' need-based experiences during a PE lesson on handstand.

Goal clarification and process feedback

Both goal clarification and process feedback are proposed as essential in the framework of assessment for learning (MacPhail and Halbert 2010; Wiliam 2011; Wiliam and Thompson 2008). Assessment for learning is defined as 'the process of seeking and interpreting evidence for use by learners and their teachers to decide where they are in their learning, where they need to go and how best to get there' (Broadfoot et al. 2002, 2–3). Within this process it is emphasised that assessment should be part of the pedagogical process (Hay 2006; Hay and Penney 2009) and integrated in the teaching and learning process (Desrosiers, Genet-Volet, and Godbout 1997; Lund and Kirk 2010).

By communicating clear and transparent expectations, goals and success criteria (i.e. goal clarification or more in general, goal specificity) (Hattie and Timperley 2007; Hay and Macdonald 2008; Redelius and Hay 2012; Wirth, Künsting, and Leutner 2009), teachers communicate in which direction students need to go and what aspects of the assignment deserve attention such that students know how to complete it successfully. Goal clarification can constitute of explicit verbal instructions, but can also take the form of a criteria sheet or video excerpts in which the goals are clarified (Hay and Penney 2009). Moreover, if students understand the goal of the lesson, they can become more self-regulated, because they are able to evaluate their current performance in relation to the desired goal (Butler and Winne 1995; MacPhail and Halbert 2010; Sadler 1989).

Students' current performance can be improved by receiving concrete strategies and hints, improving their task execution and increase their competence (i.e. process feedback, or more in general, formative feedback) (Koka and Hein 2003; Shute 2008). Process feedback focuses on improvement and provides students with the necessary step-by-step support to achieve the learning goal (Reeve 2015). For process feedback to be effective, it should deliver high quality information to students about their learning and provide opportunities to close the gap between current and desired performance (Nicol and MacFarlane-Dick 2006; Sadler 1989). The provision of spoken success feedback, i.e. emphasising strong elements in the exercise so far, and stimulating to do the same in future exercises, serves as an example of such effective process feedback. Also spoken intervention feedback, i.e. giving students corrective advice, can be provided, as it focusses on a specific suggestion for improvement (Kluger and DeNisi 1996). As such, effective feedback will set students into action (Nicol and MacFarlane-Dick 2006).

Goal clarification and process feedback: a motivational perspective

Starting from a Self-Determination Theory perspective (SDT) (Deci and Ryan 2000; Ryan and Deci 2017), a growing body of empirical research in the domain of PE has shown that goal clarification and process feedback positively relate to students' motivational functioning (Cheon, Reeve, and Song 2019; Koka and Hein 2003). According to SDT, when teachers adopt a structuring teaching style (Aelterman et al. 2019), which is the case when teachers set clear goals (Kunter, Baumert, and Köller 2007) and provide process feedback (Levesque et al. 2004; Pat-El, Tillema, and van Koppen 2012), the most volitional forms of motivation are elicited. This is because students' basic psychological needs for competence (i.e. feelings of effectiveness), autonomy (i.e. feelings of volition) and relatedness (i.e. feelings of mutual care) are supported, rather than thwarted. Clarifying the goals and providing process feedback helps students to direct their learning efforts and thereby expand their capabilities, satisfying their need for competence (Koka and Hein 2003; Kunter, Baumert, and Köller 2007; Mouratidis et al. 2013). Because their understanding of the lesson goals enables them to evaluate where they are in their learning trajectory and process feedback provides them with concrete information on how to improve, students take more ownership over their learning process, satisfying their need for autonomy (Butler and Winne 1995; Carpentier and Mageau 2016; Potdevin et al. 2018). Also, in a classroom atmosphere in which students perceive support, a more positive and caring atmosphere is created, satisfying their need for relatedness (Pat-El, Tillema, and van Koppen 2012).

In addition, according to SDT, when structure is lacking, students may experience need frustration. The absence of insight in goals and process feedback might cause feelings of inferiority and failure, frustrating their need for competence, as students do not know when a performance is 'good enough'. Also, a lack of insight in 'where to go' might give students pressure, frustrating their need for autonomy, while searching how to improve learning. Since SDT proposes that the three basic needs are interdependent (Ryan and Deci 2017), feelings of alienation, frustrating the need for relatedness (Vansteenkiste and Ryan 2013), will probably correlate with goals and feedback in a similar fashion as competence and autonomy frustration.

Only two (non-experimental) studies so far explored how goal clarification and process feedback related to students' need frustration. Haerens and colleagues (2019) did not find any relations between knowledge of expectations (i.e. goal clarification) and students' need frustration, while Krijgsman and colleagues (2019) found negative relations between the clarification of goals and students' need frustration. As for process feedback, only one study is available and no relations with students' need frustration were found (Krijgsman et al. 2019).

The present study

This quasi-experimental study examines whether the presence of goal clarification and process feedback can positively affect students' need-based experiences, in an ecologically valid setting. By relying on a quasi-experimental design and on quantitative methods enriched with qualitative methods, this study methodologically complements the available empirical research on the motivational correlates of goal clarification and process feedback which predominantly (with the exception of Cheon, Reeve, and Song 2019; Potdevin et al. 2018) relied on cross-sectional or longitudinal designs and quantitative methods only (e.g. Krijgsman et al. 2019; Levesque et al. 2004; Mouratidis et al. 2013; Pat-El, Tillema, and van Koppen 2012).

The following research question guided our study:

Does the presence of goal clarification and process feedback positively affect PE students' feelings of competence, autonomy and relatedness satisfaction and frustration, and vice versa for the absence?

We hypothesised that in the experimental condition in which the teacher clarified goals *and/ or* provided process feedback, students would report high levels of need satisfaction. Moreover, we explored in what way both teaching strategies, or the absence of both, affected students' experiences of need frustration.

Methods

Participants

The participants for the current study were recruited through the network of the first author. PE teachers were contacted and asked whether four of their seventh grade PE classes could participate in the current study. Participating classes were required to follow a general secondary education track, preparing for higher education. This invitation lead to a convenience sample consisting of five different schools that each participated with four different seventh grade PE classes. In total, across all 20 participating classes, 513 students were eligible to participate. Of these students, seventeen students (or 3.31%) did not participate because either their parents or students themselves did not consent. Another four students (or 0.78%) were absent or indisposed otherwise at the measurement occasions. The final sample consisted of 492 students ($n = 236$ boys; 48.0%, $M_{age} = 12.51$; $SD = 0.51$; range 10.53–14.68 years at baseline). The number of students per class ranged from 15 to 28 students ($M = 24.6$).

Procedure and measures

In a 2 by 2 factorial design, the four classes within each school were randomly assigned to one of the four quasi-experimental conditions: (1) absence of both goal clarification and process feedback (n = 121), (2) presence of goal clarification, absence of process feedback (n = 117), (3) absence of goal clarification, presence of process feedback (n = 126), (4) presence of both goal clarification and process feedback (n = 128).

Prior to participating in the experiment, all students first completed a questionnaire as a baseline measure considering students' experiences in PE in general. One week after completing the baseline measure, students from all conditions participated in one experimentally manipulated lesson on handstand, which were all taught by the same guest-teacher. Directly after the experimental lesson, students completed a second questionnaire, focusing on their experiences during the experimental lesson. This resulted in a total of 943 completed questionnaires (see 'analyses' section for the treatment of missing values). Before students completed the questionnaires, it was clearly communicated that there were no wrong answers, and that students' responses would be treated confidentially. Students were told that by completing the questionnaires, they would get the opportunity to inform the university and PE teachers about their experiences in PE lessons in general, and specifically during this lesson given by the guest-teacher. Completing questionnaires took about 10–15 min each. Data was collected between October and November 2017. The Ethical Committee of Utrecht University approved the study protocol.

The experiment was set-up as a lesson on handstand, for most students of this age a relatively new motor skill. The lesson was given by a guest-teacher, who is the first author and a licensed and experienced PE teacher, and was taught during regular school hours according to the normal schedule of the participating class. The guest-teacher followed a detailed and condition specific lesson-script, to provide lessons within each of the four conditions in a standardised manner.

Prior to the start of the study, the experimental lesson with presence of goals and feedback was piloted twice. Both pilots were run with seventh grade PE classes who did not participate in the final sample and were observed by a fellow PE teacher who was aware of the research objectives. Subsequently, directly after each pilot, feedback was provided in order to adapt the lesson accordingly. This way, the experimental lesson was fine-tuned and the guest-teacher had two rehearsals of the lesson-script with presence of both goals and feedback, which was the most challenging script.

All experimental lessons took on average 41 min. A research confederate, introduced as a university researcher, observed the guest-teacher to allow for a manipulation check. Only the guest-teacher and the research confederate, and not the usual PE teacher, were present during the lessons. Only the research confederate was present when students completed the questionnaires. At the end of the study, PE teachers, students and parents were fully informed about the differences between experimental conditions.

Baseline measure

All questionnaire items were assessed on a 5-point Likert scale bounded by 1 (*Strongly disagree*) and 5 (*Strongly agree*). The stem for the baseline measure was 'In general during PE class … .'

Need satisfaction and frustration. Students' experiences of competence, autonomy and relatedness satisfaction and frustration were assessed with the for PE modified Basic Psychological Need Satisfaction and Frustration Scale (BPNSFS) (Haerens et al. 2015). Each need was measured with four items, e.g. for competence satisfaction 'I feel capable at what I do', autonomy satisfaction 'I feel a sense of choice and freedom when participating in tasks', relatedness satisfaction 'I feel at ease with my teacher', competence frustration 'I feel like a failure because of the mistakes I make', autonomy frustration 'I feel pressure to do certain tasks' and relatedness frustration 'I feel that the teacher dislikes me.' Internal consistency was calculated with coefficient omega (Dunn, Baguley, and Brunsden 2014), which can be interpreted analogously to coefficient alpha, yet has less risk of overestimating or underestimating reliability. All scales were internally consistent, varying per

variable between $.68 \leq \omega \leq .92$. The lowest omega was found for relatedness frustration ($\omega = .68$), with two items loading very poorly 'I felt excluded from the group I wanted to belong to' ($\beta = .24$) and 'I felt that I did not really know the teacher' ($\beta = .37$). This poor internal consistency on these specific items could be explained by the fact that students had just started a new schoolyear at a new school, transitioning from primary to secondary school, with a new PE teacher and new classmates. For comparability reasons with previous studies, given removal of the items would lead to a two-item scale, and in light of the acceptable omega-values, these specific items were retained for analyses.

Moreover, students' anticipated experiences of competence satisfaction for handstand specifically were measured at baseline. This measure was similar to the competence satisfaction measure as described above yet used the stem 'Imagine you would participate in a handstand lesson. How do you feel about these statements?'. The scale was internally consistent with $\omega = .92$. Since this scale was adapted from the original scale, factorial validity was tested. The model fitted the data very well, $\chi^2(2) = 1.88$, $p = .39$, RMSEA = .00, CFI = 1.00 and SRMR = .01. All indicator loadings ranged between .65 and .93, $p < .001$.

Experimental manipulation

For the purpose of standardisation, each lesson consisted of a general and firmly scripted introduction, followed by a practice phase including scripted teacher contact and instruction of the exercises through videos on an iPad, and a scripted lesson closure. The standardised lesson, which constitutes the basis for all four conditions, is presented in Table 1. The videos and standardised feedback are presented as supplemental online material. The additional steps that were taken in the conditions in which goal clarification and process feedback were provided, are presented in Appendix A. Lesson-scripts are available upon request from the first author.

In all four conditions, students watched exercises displayed on the iPad, which were arranged by four levels of difficulty, named the green, blue, red and black slope, analogous with ski slopes coding, with the green slope being the easiest level and the black slope being the most difficult level. This way, students in all four conditions, including those who would not get goals and feedback, could work independently and safe from injuries for the planned 40 min-lesson. To avoid students being distracted because of other iPad applications, indicated as a pitfall for novice iPad learning (Bodsworth and Goodyear 2017) and congruent with students' behaviour in our pilot lessons, students could only use the video-app, as all other functionalities of the iPad were password protected.

Goal clarification conditions. Additional to the standardised condition, the goal clarification conditions comprised seven extra steps (see Appendix A). To provide students with insights in the guest-teacher's expectations for the upcoming lesson, students watched a one-minute video displaying the expected beginning and end level for all levels of difficulty. Based on this video, they were asked to make an informed choice about the level they would like to attain. In step 2-7, awareness was created about the general lesson goal by explicitly writing the goal at the beginning of the video: 'do a straight handstand on your own level of difficulty', and by explicitly writing the main focus per level of difficulty in the video, for instance for the green slope: 'keep shoulders above hands or elbows'.

Process feedback conditions. Additional to the standardised condition, the process feedback conditions comprised five extra steps (see Appendix A). The teacher informed the students that, while practising, they would receive feedback that would help them improve. In step 2-5, the focus was on informing students about one strong element, providing them with success feedback, and one suggestion for improvement, providing them with intervention feedback. Both types of feedback (see supplemental online materials) were standardised per level of difficulty. The guest-teacher, who remembered the feedback by heart, provided the process feedback congruent with the level of difficulty of the exercises students were working on. These remarks were alternated directed towards individual students, groups or the whole class.

Table 1. Design of the standardised experimental condition: absence of goal clarification and process feedback.

Lesson phase		
Introduction	Practise	Lesson closure
1. The teacher informed the students that the lesson was about handstand.	10. The teacher interrupted each group on a minimum of two occasions and said (1) 'come on, get back to your exercises' or 'well done' depending on the actual situation in that group and requested to look at the video-example once again.	13. The teacher thanked the students and informed them that the university researcher would now take over to conduct the questionnaires.
2. Students were asked 'Are you a novice in handstand? Please sit on the bench with the green sticker. Are you a bit familiar with the handstand? Please sit on the 'blue bench'. Can you already perform the handstand? Go to the 'red bench'. Are you an expert in the handstand? Go to the 'black bench'.'	11. Teachers' verbal instruction towards the class: a. Switching between levels is possible. b. Practise two or three new exercises during the last five minutes of the lesson.	
3. Students did a warm-up.		
4. Homogeneous groups of approximately four students were made. There were four levels of difficulty: green – blue – red – black.		
5. The teacher told the students that they were expected to work self-sufficiently.		
6. The teacher explained how they would work during the lesson: a. Each group receives one iPad with instructional videos on it. b. Watch the first exercise of your level of difficulty; c. Practise this specific exercise exactly as shown in the video; d. Successfully performed? Watch and practise the next exercise; e. Not successfully? Practise again.		
7. The teacher indicated that the gym was divided in four quarters: one quarter per level of difficulty.		

Note. See Appendix A for more information on the three manipulated conditions.

Goal clarification and process feedback condition. Additional to the standardised condition, the manipulations were a combination of both goal clarification and process feedback. Moreover, goals and process feedback were aligned (MacPhail, Tannehill, and Goc Karp 2013). To deliver the scripted instruction aligned, the teacher used more instruction time compared to the other conditions.

Manipulation check and effect measures

All questionnaire items were assessed on a 5-point Likert scale anchored by 1 (*Strongly disagree*) and 5 (*Strongly agree*). The stem for the effect measure was lesson focussed, i.e. 'While we were practising during the previous PE class … ', or 'During the previous PE class … '.

Manipulation check. Students' perceptions of the provided goal clarification and process feedback by the teacher were measured with four items each that were developed specifically for the current study, for instance for goal clarification 'During the beginning of the previous PE class, the teacher explained the goal she wanted to reach', and for process feedback 'While we were practising

during the previous PE class, the teacher explained to our group how we could improve'. Both scales were internally consistent with $\omega_{goalclarification} = .82$ and $\omega_{processfeedback} = .91$. Since this scale was developed for this study, factorial validity was tested. The model fitted the data very well, $\chi^2(19) = 52.16$, $p < .001$, RMSEA = .06, CFI = .98 and SRMR = .04. All indicator loadings ranged between .48 and .88, $p < .001$.

Moreover, the research assistant observed the teacher to see whether results from the quantitative manipulation check could be confirmed. During observation, the specific lesson script and an accompanied coding scheme were filled-out, in order to describe as exact as possible, what happened during the lesson.

Need satisfaction and frustration. Students' experiences of competence, autonomy and relatedness satisfaction and frustration were assessed analogously to the baseline measure. All scales were internally consistent, varying per variable between $.63 \leq \omega \leq .89$. The lowest omega was found for relatedness frustration ($\omega = .63$), with again the same two items loading very poorly 'I felt excluded from the group I wanted to belong to' ($\beta = .26$) and 'I felt that I did not really know the teacher' ($\beta = .25$). Next, we tested for measurement invariance (see Table 2 for fit indices) to ensure that students interpreted the items similarly in the baseline and effect measure (i.e. metric invariance; van de Schoot, Lugtig, and Hox 2012) and to make sure that the intra-individual variability in our main variables was not due to a different interpretation of the items during the two measurements. Comparisons of the CFI (Cheung and Rensvold 2009) for the configural versus metric invariance models yielded $\Delta CFI = .00$, which indicated no meaningful decrement in fit among these models, suggesting evidence for metric invariance.

Open questions about general liking of the lessons. Additionally, students answered two open questions to get a better impression of their experiences: 'Did you or didn't you like working in groups, organised by level of difficulty? Explain please.' and 'Mention one thing that you liked and one thing that you didn't like about this lesson. Explain please.'.

Analyses

Missing data

Unit non-response (van Buuren 2012) existed as not all participants completed both measurements; $n = 475$ completed the baseline-measurement, $n = 468$ completed the effect-measurement. On average, 4.17% of missing data existed per measurement occasion, with a range between conditions of 3.13% – 5.13% due to no class participation for reasons such as minor sports and leisure injuries or illness. This was accounted for by multilevel analyses. Item non-response (van Buuren 2012) was on average relatively small: 0.82%, with a range between conditions of 0.62%–1.22% and was treated with pairwise deletion.

Analytic strategy

We first inspected descriptive statistics in SPSS version 23. To examine the comparability of the experimental conditions, we tested for significant differences in gender and all outcome variables at baseline through two-level multilevel regression analyses, with students nested within classes, in MLwiN version 2.31.

Table 2. Goodness of fit indices for measurement invariance model.

	Chi-square test	SRMR	RMSEA 90% CI	CFI	TLI	AIC	BIC
			Need satisfaction and frustration				
Configural invariance	χ^2 (474) = 1146.54***	0.06	.06 [.05, .06]	0.92	0.91	52,687	53,531
Metric invariance	χ^2 (492) = 1218.86***	0.07	.06 [.05, .06]	0.92	0.90	52,723	53,480

Note: SRMR = Standardised Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; TLI = Tucker Lewis Index; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.
***$p < .001$.

To address our main research question on the effects of goal clarification and process feedback, we used three-level multilevel regression analyses, with occasions nested within students and classes, and separate models per dependent variable. First, variance components models (M0) were fitted. Next (M1), Occasion, Condition and the cross-level interaction between Occasion and Condition were entered into the model. Finally, the main model (M2) also included the covariate Gender (0/1). Gender was deemed important because, in line with earlier studies (De Meyer et al. 2016; Nicaise et al. 2007), our own findings pointed to significant differences in need satisfaction and frustration according to Gender.

Answers to open-ended questions were processed with NVivo 12 Mac. Similar to the Framework Analysis Method (Gale et al. 2013), two independent researchers manually reviewed and inductively coded answers of one class, seeking similarities, differences and items of particular interest. Then, coding of this particular class was discussed until a consensus was reached on a codebook, facilitating a systematic procedure. Subsequently, all data was coded by the two researchers. Afterwards, both researchers allocated themes and interpreted the data individually before discussing their findings. Data from both open questions was merged and will be reported jointly.

Results

Preliminary analyses

Descriptive statistics per condition among all study variables and Pearson correlations between measured variables at post-test are reported in respectively Tables 3 and 4. At baseline, no significant differences between conditions for the variables gender, need satisfaction and frustration (for means, see Table 3) were shown. At post-test, student means in reported need satisfaction were $M = 3.58$ and for need frustration $M = 1.99$. Correlations between goal clarification and process feedback per condition (see Table 3) were stronger in conditions in which goals were clarified when compared to the conditions in which no goals were clarified.

Manipulation check

Multilevel regression analyses showed that students in conditions where goal clarification was present, also perceived that the teacher clarified more goals when compared to conditions where goal clarification was absent (see Table 3 and Figure 1). Students in conditions where process feedback was present also perceived that the teacher gave more process feedback when compared to conditions where process feedback was absent (see Table 3 and Figure 1), suggesting that the manipulations were provided according to the lesson-scripts.

These findings were confirmed by logs on a filled-out lesson script and coding scheme noted by the observing research confederate. Observations indicated that, overall, the guest-teacher delivered the lessons as prepared in the lesson-scripts.

Primary analyses

Quantitative student data

The Intraclass Correlation Coefficient (ICC; Lüdtke et al. 2009) (M0; Table 5) for competence, autonomy and relatedness satisfaction and frustration revealed that most variance could be attributed to differences between occasions. These differences between baseline and post-test ranged between 94% for relatedness frustration and 66% for competence frustration (see Table 3). Adding the predictors Occasion, Condition and the cross-level interaction Occasion × Condition (M1; Table 5) and, subsequently, adding the covariate Gender (M2; Table 5) improved the model fit in both models (M1 and M2) significantly for respectively five and four out of six need variables (see −2*log likelihood in Table 5). None out of eighteen potential Occasion × Condition effects were

Table 3. Descriptive statistics of all study variables at baseline and post-experimental, check of comparability of conditions and manipulation check.

	No GC, No PF; $n = 121$		Yes GC, No PF; $n = 117$		No GC, Yes PF; $n = 126$		Yes GC, Yes PF; $n = 128$		
	Baseline *M (SD)*	Post *M (SD)*	Baseline *M (SD)*	Post *M (SD)*	Baseline *M (SD)*	Post *M (SD)*	Baseline *M (SD)*	Post *M (SD)*	
1. Goal clarification		3.22 (0.90)[a]		4.20 (0.64)[b]		3.67 (0.83)[c]		4.17 (0.63)[b]	
2. Process feedback		2.82 (1.03)[a]		3.61 (0.89)[b]		4.45 (0.61)[c]		3.99 (0.90)[d]	
3. Competence satisfaction	3.85 (0.70)[a]	3.57 (0.84)[a]	3.89 (0.64)[a]	3.50 (0.91)[a]	3.84 (0.64)[a]	3.54 (0.88)[a]	3.81 (0.59)[a]	3.60 (0.84)[a]	
4. Autonomy satisfaction	3.52 (0.61)[a]	3.28 (0.97)[a]	3.73 (0.56)[a]	3.29 (0.95)[a]	3.52 (0.65)[a]	3.35 (0.93)[a]	3.53 (0.58)[a]	3.30 (0.97)[a]	
5. Relatedness satisfaction	4.13 (0.55)[a]	3.91 (0.78)[a]	4.03 (0.67)[a]	3.90 (0.79)[a]	3.94 (0.73)[a]	3.84 (0.78)[a]	4.00 (0.57)[a]	3.85 (0.83)[a]	
6. Competence frustration	1.80 (0.85)[a]	1.93 (0.76)[a]	1.89 (0.66)[a]	2.08 (0.85)[a]	1.85 (0.72)[a]	2.04 (0.78)[a]	1.85 (0.71)[a]	1.92 (0.71)[a]	
7. Autonomy frustration	2.36 (0.83)[a]	2.16 (0.90)[a]	2.15 (0.73)[a]	2.19 (1.00)[a]	2.29 (0.74)[a]	2.16 (0.90)[a]	2.33 (0.71)[a]	2.22 (0.77)[a]	
8. Relatedness frustration	1.58 (0.51)[a]	1.77 (0.47)[a]	1.63 (0.42)[a]	1.79 (0.57)[a]	1.70 (0.50)[a]	1.75 (0.50)[a]	1.66 (0.42)[a]	1.85 (0.49)[a]	
9. Anticipated competence satisfaction handstand	2.99 (1.09)[a]		2.81 (1.11)[a]		2.97 (1.05)[a]		2.93 (1.13)[a]		
	% boys		% boys		% boys		% boys		
10. Gender	51.20[a]		45.30[a]		50.80[a]		44.50[a]		
r GC – PF	.36***		.54***		.37***		.51***		
	1	2	3	4	5	6	7	8	9
% variance class-level	.26**	.36**	.00	.03	.05*	.00	.04	.03	.04
% variance student-level	.74***	.64***	.20***	.09	.10*	.34***	.19***	.03	.96***
% variance occasion-level			.80***	.88***	.85***	.66***	.78***	.94***	

Note: *M* and *SD* calculated with measurements not controlled for nesting in classrooms and students. No GC, No PF: absence of both goal clarification and process feedback; Yes GC, No PF: presence of goal clarification, absence of process feedback; No GC, Yes PF: absence of goal clarification, presence of process feedback; Yes GC, Yes PF: presence of both goal clarification and process feedback. To calculate comparability of conditions: Regression equations, controlled for nesting in classrooms and students, were repeated several times by changing the reference category to obtain coefficients for all combinations of conditions. Conditions with dissimilar superscripts are significantly different. Differences in the extent to which students experienced that goal clarification was provided by the teacher were significant at least at the $p < .01$ level, for process feedback at least at the $p < .05$ level.

*$p < .05$. **$p < .01$. ***$p < .001$.

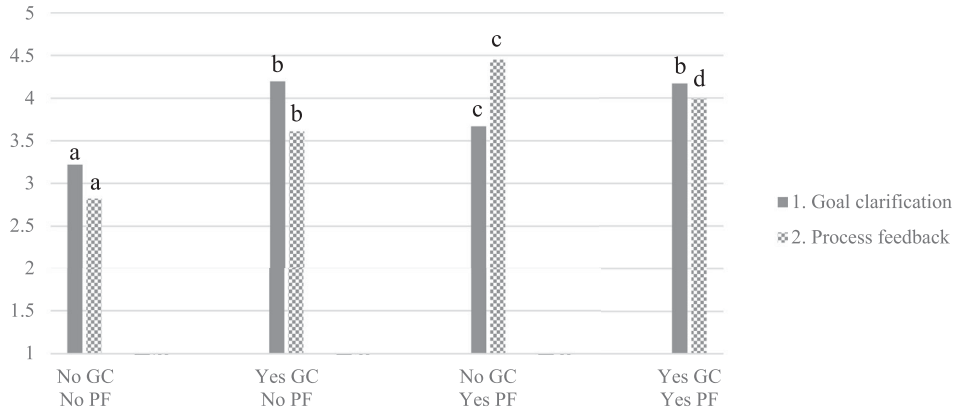

Figure 1. Comparability of conditions. Conditions with dissimilar superscripts are significantly different.

Table 4. Pearson correlations between measured variables at post-test.

Variable	1	2	3	4	5	6	7	8
1. Goal clarification		.44***	.30***	.35***	.35***	−.10*	−.22***	−.19***
2. Process feedback			.29***	.36***	.33***	−.13**	−.21***	−.21***
3. Competence satisfaction				.56***	.49***	−.55***	−.44***	−.27***
4. Autonomy satisfaction					.66***	−.29***	−.54***	−.40***
5. Relatedness satisfaction						−.25***	−.47***	−.46***
6. Competence frustration							.45***	.35***
7. Autonomy frustration								.45***
8. Relatedness frustration								

Note: *$p < .05$. **$p < .01$. ***$p < .001$.

significant (all $\chi^2 < 3.00$, $df = 1$, all $p \geq .083$; see Table 5). Also the main effects of Condition were insignificant (all $\chi^2 < 1.45$, $df = 1$, all $p \geq .29$; see Table 5). There were five main effects for Occasion. Students experienced more competence satisfaction ($\chi^2 = 10.79$, $df = 1$, $p \leq .01$), autonomy satisfaction ($\chi^2 = 5.82$, $df = 1$, $p \leq .05$), relatedness satisfaction ($\chi^2 = 6.20$, $df = 1$, $p \leq .05$) and autonomy frustration ($\chi^2 = 4.20$, $df = 1$, $p \leq .05$), yet less relatedness frustration ($\chi^2 = 9.56$, $df = 1$, $p \leq .01$) during PE in general when compared to the experimental lesson on handstand. Supplementary analyses showed that regardless of the experimental manipulation, students experienced more competence satisfaction in the experimental handstand lesson when compared to their anticipated feelings of competence regarding a lesson on handstand at baseline ($\chi^2 = 39.19$, $df = 1$, $p \leq .001$).

Qualitative student data

The majority of students, regardless of the experimental manipulation they were in, indicated that several aspects of the experimental lesson were much appreciated. See Table 6 for an overview of examples of students' answers. First, students indicated to have experienced competence satisfaction during the experimental lesson. They liked working on their own level of difficulty, felt growth in their capabilities, enjoyed the challenge, reported that it gave them a learning opportunity and that it provoked positive emotions when mastering an exercise. Also, a lot of students mentioned that they appreciated working in homogeneously skilled groups. Second, students reported to experience autonomy satisfaction during the experimental lesson. A lot of students reported enjoying giving and receiving feedback – even in conditions in which no feedback was provided – and as such, liked to learn from each other. Students appreciated working at their own pace and experiencing a sense of independency. Third, students experienced relatedness satisfaction during the experimental

Table 5. Effect of teaching behaviour regarding goal clarification and process feedback on students' feelings of competence, autonomy and relatedness satisfaction and frustration.

	Competence satisfaction			Autonomy satisfaction			Relatedness satisfaction		
Parameter	M0a *b (SE)*	M1a *b (SE)*	M2a *b (SE)*	M0b *b (SE)*	M1b *b (SE)*	M2b *b (SE)*	M0c *b (SE)*	M1c *b (SE)*	M2c *b (SE)*
					Fixed part				
Intercept	3.70(.03)	3.57(.07)	3.59(.08)	3.44(.04)	3.29(.08)	3.15(.10)	3.96(.04)	3.92(.09)	3.82(.10)
Occasion level									
Time: baseline[a]		.28(.09)**	.28(.09)**		.24(.10)*	.23(.10)*		.22(.09)*	.21(.09)*
Student level									
Students' gender[b]			−.05(.06)			.30(.05)***			.20(.05)***
Class level									
Condition[c]									
Yes goal clarification, no process feedback	−.06(.10)	−.06(.10)		.00(.13)	−.02(.13)		−.01(.13)	−.03(.13)	
No goal clarification, yes process feedback	−.03(.10)	−.03(.10)		.06(.13)	.05(.13)		−.08(.13)	−.09(.13)	
Yes goal clarification, yes process feedback	.04(.10)	.05(.10)		.01(.13)	−.01(.13)		−.06(.13)	−.08(.13)	
Cross-level interaction									
YesGC noPF X baseline		.11(.12)	.11(.12)		.21(.14)	.22(.14)		−.08(.12)	−.08(.12)
NoGC yesPF X baseline		.03(.12)	.03(.12)		−.06(.14)	−.05(.14)		−.12(.12)	−.11(.12)
YesGC yesPF X baseline		−.08(.12)	−.08(.12)		.01(.13)	.01(.13)		−.06(.12)	−.06(.12)
					Random part				
σ^2_ξ (Occasion)	.48(.03)***	.43(.03)***	.43(.03)***	.58(.04)***	.53(.04)***	.53(.04)***	.44(.03)***	.43(.03)***	.43(.03)***
σ^2_{v0} (Student)	.12(.03)***	.15(.03)***	.15(.03)***	.06(.03)	.08(.03)**	.06(.03)*	.05(.02)*	.06(.02)*	.05(.02)*
σ^2_{u0} (Class)	.00(.00)	.00(.00)	.00(.00)	.02(.01)	.02(.01)	.02(.01)	.03(.01)*	.02(.01)*	.02(.01)*
−2*log likelihood (df)		47.09(7)***	0.87(1)		36.37(7)***	30.1(1)***		14.78(7)*	17.70(1)***

	Competence frustration			Autonomy frustration			Relatedness frustration		
Parameter	M0d *b (SE)*	M1d *b (SE)*	M2fd *b (SE)*	M0e *b (SE)*	M1e *b (SE)*	M2e *b (SE)*	M0f *b (SE)*	M1f *b (SE)*	M2f *b (SE)*
					Fixed part				
Intercept	1.92(.03)	1.94(.07)	1.90(.08)	2.23(.05)	2.16(.10)	2.26(.10)	1.72(.03)	1.77(.06)	1.83(.06)
Occasion level									
Time: baseline[a]		−.15(.08)	−.15(.08)		.19(.10)*	.20(.10)*		−.19(.06)**	−.19(.06)**
Student level									
Students' gender[b]			.08(.06)			−.21(.06)***			−.12(.03)***
Class level									
Condition[c]									
Yes goal clarification, no process feedback		.13(.10)	.12(.10)		.03(.14)	.05(.14)		.02(.08)	.03(.08)
No goal clarification, yes process feedback		.10(.10)	.09(.10)		.00(.14)	.01(.14)		−.02(.08)	−.01(.08)
Yes goal clarification, yes process feedback		−.03(.10)	−.04(.10)		.06(.14)	.08(.14)		.08(.08)	.09(.08)
Cross-level interaction									

(*Continued*)

Table 5. Continued.

	Competence frustration			Autonomy frustration			Relatedness frustration		
Parameter	M0d *b (SE)*	M1d *b (SE)*	M2fd *b (SE)*	M0e *b (SE)*	M1e *b (SE)*	M2e *b (SE)*	M0f *b (SE)*	M1f *b (SE)*	M2f *b (SE)*
YesGC noPF X baseline		−.03(.12)	−.03(.12)		−.23(.14)	−.24(.14)		.02(.09)	.02(.09)
NoGC yesPF X baseline		−.04(.11)	−.04(.11)		−.07(.13)	−.07(.13)		.13(.09)	.13(.09)
YesGC yesPF X baseline		.08(.11)	.08(.11)		−.08(.13)	−.08(.13)		−.01(.09)	.01(.09)
					Random part				
σ^2_e (Occasion)	.38(.03)***	.37(.02)***	.37(.02)***	.53(.04)***	.52(.04)***	.52(.04)***	.23(.02)***	.21(.01)***	.21(.01)***
σ^2_{v0} (Student)	.20(.03)***	.20(.03)***	.20(.03)***	.13(.03)***	.13(.03)***	.12(.03)***	.01(.01)	.02(.01)	.01(.01)
σ^2_{u0} (Class)	.00(.00)	.00(.00)	.00(.00)	.02(.01)	.02(.01)	.02(.01)	.01(.00)	.01(.00)	.01(.00)
−2*log likelihood (df)		16.85(7)*	2.20(1)ns		8.4(7)ns	12.61(1)***		28.08(7)***	13.85(1)***

Note: Values in parentheses are standard errors. Reference category = 0: [a]0 = posttest, 1 = baseline; [b]0 = boy, 1 = girl; [c]0 = No goal clarification, no process feedback, 1 = Yes goal clarification, no process feedback, 2 = No goal clarification, yes process feedback, 3 = Yes goal clarification, yes process feedback.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 6. Examples of students' reactions to the open questions about the experimental lesson.

Student number	Slope	Key concept	Comment
31007	red	Competence satisfaction	'I liked it, because I could participate on a level that is not too easy and not too difficult.'
51801	green		'I liked the exercises. It feels like I've improved my handstand.'
31009	green		'A handstand with support from the box, this was exciting.'
51706	green		'When I performed the handstand against the wall. It made me feel really good.'
10407	red		'We learned more. I really liked that.'
10307	blue		'It is nice when others in your group can do the same as you can.'
51908	blue	Autonomy satisfaction	'I really liked it, because I could ask for feedback and I could give feedback to my classmates.'
51911	blue		'This way, we did not need to wait for students that were not so good at it.'
31121	red		'Working on your own with the group. It gives a feeling of independency.'
20614	red	Relatedness satisfaction	'I liked working in groups. We had a nice atmosphere in our group and we could help each other.'
31104	green		'I felt free and the teacher's instructions and help were very clear. The teacher was friendly.'
20707	blue	Competence frustration	'I don't like the handstand. I can't do it.'
31106	blue		'I totally suck at it. I was afraid of falling.'
51722	blue	Lesson subject	'I enjoyed everything! It's just so much more fun than soccer or something like that.'
41609	blue		'I don't like handstand. It's boring.'
31124	blue	Didactical approach	'I liked it. It's something else. We never do this.'
20714	blue		'I didn't like it. It was too much of the same thing. It became rather boring.'
30922	blue	IPad	'Working with videos was nice. We could replay the example.'
41608	black		'The exercises and the videos on the iPad were nice. The videos gave clear instructions and an iPad is fun.'

lesson. They frequently commented on the nice atmosphere in the class, their relationship with others, and on the teacher's teaching style.

In contrast, there was also a group of students who commented negatively on their capabilities in the experimental lesson. These students indicated that they were not good at performing a handstand, experienced fear of failure and indicated that certain exercises were too difficult, or in other words, indicating feelings of competence frustration.

Besides need-based related aspects of the experimental lesson, a large number of students commented on three other aspects. First, there were comments on the lesson's subject of handstand. Approximately half of these were positive, and the other half were negative. Second, a lot of students commented positively on the didactical approach of the lesson, either in general or because it was either 'new' or 'something else'. A minority of students preferred more variation, reporting that they found the lesson boring. Third, students enjoyed working with instruction videos on an iPad because they experienced it as novel, clear, well-arranged, fun, or supportive.

Discussion

The importance of both goal clarification and process feedback (Hay and Penney 2009, 2013; Leirhaug and Annerstedt 2016; MacPhail and Halbert 2010) for students' motivation (Cheon, Reeve, and Song 2019; Koka and Hein 2003) towards PE has recently received more and more attention. Observations of PE lessons have demonstrated that the implementation of goal clarification and process feedback shows room for improvement (Leirhaug and Annerstedt 2016; Leirhaug and MacPhail 2015; López-Pastor et al. 2013) and concrete evidence-based practices of how this can be done are warranted (Georgakis and Wilson 2012; Ní Chóinín and Cosgrave 2013). Prior studies in the PE context reported mostly on students' perceptions of their teachers' naturally occurring and non-manipulated teaching style regarding goal clarification and process feedback (with the exception of Cheon, Reeve, and Song 2019; Potdevin et al. 2018), and available evidence predominantly relied on cross-sectional or longitudinal designs and quantitative methods only (e.g. Koka and Hein 2003;

Krijgsman et al. 2019). The present study aimed to contribute to the literature by experimentally manipulating the teachers' teaching style regarding goal clarification and process feedback in an ecologically valid context, and examining its impact on students' need-based experiences using both quantitative and qualitative methods. Advancing our understanding regarding how teachers can affect students' experiences of need satisfaction and frustration is important, as need satisfaction has been shown to relate to positive educational outcomes such as engagement (Jang, Kim, and Reeve 2016) and learning (Mouratidis et al. 2013), while need frustration has shown to yield unique relations with maladaptive educational outcomes such as amotivation, fear (Krijgsman et al. 2017) and ill-being (Haerens et al. 2015; Vansteenkiste and Ryan 2013).

Goal clarification, process feedback and need-based outcomes

Our main aim was to examine the extent to which goal clarification and process feedback affected PE students' perceived competence, autonomy and relatedness satisfaction and frustration. The experimental manipulations were effective with students reporting more goal clarification and/or process feedback when this was implemented by the guest-teacher in line with the script. Surprisingly, these differences in goal clarification and process feedback did not translate into differences in students' need-based experiences across the four conditions. Indeed, rejecting our hypothesis, we found that, regardless of whether students received additional verbal goal clarification and/or process feedback, students felt equally effective (i.e. competence satisfaction; Mouratidis et al. 2013), in charge of their learning process (i.e. autonomy satisfaction; Carpentier and Mageau 2016) and connected and cared for (i.e. relatedness satisfaction; Pat-El, Tillema, and van Koppen 2012). In line with results found for need satisfaction, the experimentally manipulated verbal goal clarification and process feedback did not affect students' need frustration, as students felt equally frustrated in their need for competence, autonomy and relatedness in all four conditions. Said differently, the way in which the teacher implemented goals clarification and process feedback in the manipulated conditions did not decrease students' need frustration.

Yet, correlations between perceived goal clarification, process feedback and students' need satisfaction and frustration (see Table 4) were in line with theoretical (Butler and Winne 1995; Hattie and Timperley 2007; Sadler 1989) and empirical literature in which it is argued that students who are more knowledgeable about goals (Kunter, Baumert, and Köller 2007; Mouratidis et al. 2013) and who perceive to receive more process feedback (Koka and Hein 2003; Pat-El, Tillema, and van Koppen 2012) or both (Krijgsman et al. 2019), will feel more effective and self-regulated in their learning, experiencing higher need satisfaction, and lower need frustration.

Altogether, these findings suggest that the experimentally implemented goal clarification and process feedback were noted by the students (see Table 3 and Figure 1), yet these differences did not yield the expected benefits for students' need satisfaction and frustration, suggesting that the effects of the manipulation were too small.

Explaining the lack of effects on need-based experiences

The lack of effect of the manipulated conditions is noteworthy as previous experimental studies provided evidence that short experimental manipulations, as the ones provided in the current study, can positively affect students' motivational functioning. Such evidence, that short (single-lesson) experimental manipulations work, was already provided by Edward Deci in 1971 when he showed that verbal reinforcement and positive feedback as external awards seemed to increase psychology students' intrinsic motivation relative to the non-rewarded students. Other more recent experimental studies confirm that motivational functioning can be influenced in one-single lesson manipulations. For instance Gonzalez and Chiviacowsky (2018) showed that when instructions for a swimming task were provided in a more relatedness supporting versus relatedness thwarting way, positive effects on youngsters' motivational functioning were noted. De Muynck et al. (2017) showed that positive feedback versus negative feedback during a tennis task positively influenced youngsters' competence

satisfaction, enjoyment and perseverance. In both fairly recent experiments, in the lesson-instructions, only three sentences were different between the experimental conditions. Together, this evidence shows that short manipulations do have the potential to affect students' need-based experiences on a momentary basis. Yet, why was this not the case in the present study?

We hypothesise that the use of instructional videos in the standardised condition (see Table 1) contaminated our results in several ways. First, the presence of the instructional videos may have allowed students to self-generate the goal of the lesson (Hay and Penney 2009), and to provide each other with process feedback (Potdevin et al. 2018). This may have been equally motivating than to receive this information from the teacher. In line with this explanation, qualitative data analyses indeed revealed that students in all conditions, also the standardised condition, perceived the videos as clarifying (e.g. 'The videos gave clear instructions'). Also, students had enjoyed giving and receiving peer feedback (e.g. 'I really liked it, because I could ask for feedback and I could give feedback to my classmates'). Only two students from the standardised condition commented negatively about a lack of instruction or solely receiving instruction via videos.

Second, when compared to prior research (e.g. De Meyer et al. 2016; Haerens et al. 2015), students in all four conditions appeared to have experienced high levels of need satisfaction, which may also be due to the instructional videos on the iPads. In line with this reasoning, qualitative data revealed that students experienced the use of iPads as well-arranged, novel and fun, contributing to feelings of autonomy. The use of instructional videos on the iPads also allowed students to choose the level of difficulty they wanted to practise on and the pace by which they moved from one exercise to another, contributing to feelings of autonomy and competence. Moreover, the instructional videos allowed students to collaborate intensively with classmates, contributing to feelings of relatedness. We also hypothesise that the experienced high levels of need satisfaction in all conditions might be due to the novelty effect that might have been enlarged because a new guest-teacher taught the lesson.

Relationship between goal clarification and process feedback

Results revealed that a relationship between goal clarification and process feedback existed, as in the presence of goal clarification, students indicated to have received more process feedback, even when no additional process feedback was provided by the teacher (see Table 3 and Figure 1; also see for instance Aelterman et al. 2019; Krijgsman et al. 2019; Pat-El, Tillema, and van Koppen 2012 for the relationship between goals and feedback). Said differently, also students in the goal clarification condition without any additional process feedback experienced to have received more process feedback than students in the standardised condition who also did not receive any additional feedback. This suggests that when the goals of lessons are clarified and students therefore know the direction they need to work towards, they might be able to self-generate internal feedback (Butler and Winne 1995).

Similarly, students in the process feedback conditions (i.e. the students who received both goals and feedback, but also the students who were only provided with process feedback, no goal clarification) experienced to have received more goal clarification than students in the standardised condition (see Table 3 and Figure 1). This suggests that students are able to filter which goal is pursued from the process feedback they receive, even when the goals are not explicitly clarified.

Students' need satisfaction in a physical education lesson on handstand

Interestingly, students' need satisfaction decreased from baseline to post-test. Apparently, students experienced more need satisfaction during PE in general, as compared to a specific lesson on handstand. Qualitative data indeed revealed that a large number of students indicated to dislike the subject handstand, as is in line with previous research reporting that the subject of the lesson is related to students' motivational functioning (Aelterman et al. 2012). It was therefore encouraging to find that

students experienced more competence satisfaction during the experimental lesson than they expected to feel in a handstand lesson.

Limitations and future directions

In order to standardise the experimental lesson as much as possible, a high level of structure was provided to all students. IPads were used to standardise instructions, and to make sure that *all* students could work independently and safely for the planned 40 min-lesson, even without verbal instructions provided by the teacher. Qualitative data suggests that this 'iPad-approach' and its videos may have interfered with our manipulations as students may have been able to self-generate the goals and to provide process feedback to themselves and others. These qualitative findings could not be tested through the quantitative data as in the present study, students from all conditions used an iPad, making it, in retrospect unfortunately, impossible to test the actual interference of the iPad. Therefore, it would be interesting to replicate this experiment with an additional condition: a standardised lesson that uses a more conventional approach, in which students would get instruction from the teacher without having the advantages of iPad-usage and videos. The videos allowed to view the demonstration of the exercise as many times as desired, choices and challenges were provided and students were allowed to work in homogeneous groups, which appeared to be highly motivating. The iPad-usage and its videos were thus a contaminating factor in the current study.

In addition, the results of the present study indicated a certain spill-over in goal clarification and process feedback, with students who received goal clarification, being able to self-generate internal feedback. To provide a more refined insight in the perception of goal clarification and process feedback by students in a school-based setting, future research could further investigate this issue.

Implications for education

Students in the present study experienced the instructional videos on the iPad (see supplemental online material), explaining exercises with various difficulty levels, as highly motivating. This is because students could work in small and homogeneous groups, on their own level of difficulty, and gave them the opportunity to self-discover the goals of the lesson and provide each other with feedback. Although additional verbal goal clarification and process feedback by the teacher did not get in the way of students' need-based experiences, our results show that even when the teacher does not provide goals and feedback, under these lesson-conditions, students are equally motivated to participate in the lesson. Therefore, we recommend teachers to use the present videos and to develop such instructional videos for various curriculum domains.

Conclusion

Results showed differences in goal clarification and process feedback when comparing all four experimental conditions, suggesting that the manipulations were provided according to the condition specific lesson-scripts. Nevertheless, these differences did not translate into differences in need-based experiences, as students were equally satisfied in their need for competence, autonomy and relatedness regardless of whether they were provided with both goals and feedback, only goals or feedback or none. Similar results were found for students' perceived need frustration. In general, additional quantitative and qualitative analyses indicated that aspects of the experimental lesson made students feel effective, in charge over their own learning and experiencing a positive classroom atmosphere.

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Appendix A.

Table A1. Goal clarification and process feedback manipulations: additional steps.

Conditions with goal clarification: additional steps	Conditions with process feedback: additional steps
Step 1: Students watched a one-minute video displaying the expected beginning and end level for all levels of difficulty (i.e. creating insight in expectations). Based on this video, they were asked to make an informed choice. **Step 2:** The teacher informed the students about the general lesson goal (i.e. 'do a straight handstand on your own level of difficulty').**Step 3:** The teacher emphasised that there was one specific main focus per level of difficulty (e.g. main focus of the easiest level: 'keep shoulders above your hands and/ or elbows'), which was written above every video. **Step 4:** During the practise phase, the teacher asked each group of students which main focus was written in the video that they were practising. When students could not recall the main focus, they were asked to look at the video again. When they could recall the main focus, they were instructed to pay attention to that specific aspect and then immediately, the teacher left that group to avoid questions about 'how am I doing'.**Step 5:** When pausing the class' exercising, the teacher emphasised a main focus that was important for a lot of students (i.e. 'belly tucked in, bottom tight') and asked them to pay attention to this aspect. **Step 6:** When pausing the class' exercising for a second time, the teacher asked the students to recall the main focus for their level of difficulty and allowed responses from two students. **Step 7:** During the lesson closure, the teacher asked two students to recall their main focus and encouraged the students to remember this when practising the handstand in future PE lessons.	**Step 1:** At the start of the lesson, the teacher informed the students that, while practising, they would receive feedback that would help them improve. **Step 2:** During the prastice phase, the teacher informed students (in person or in a group of students when applicable) about one strong element and one suggestion for improvement (see supplemental online material for the standardised feedback). **Step 3:** When pausing the class' exercising, the teacher provided the students with a strong element and a suggestion for improvement that was applicable for almost the whole group. **Step 4:** When pausing the class' exercising for a second time, the teacher asked the students to recall one personal strong element and suggestion for improvement. **Step 5:** During the lesson closure, the teacher asked two students to recall their suggestion for improvement and encouraged the students to remember this when practising the handstand in future PE lessons.